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(54) **Forceps**

(57) Forceps having gripper fingers (31) which are resilient and naturally biassed into an open condition have the tips (32) of the fingers coated with diamond particles. The gripping of the gripper tips is accomplished by the forward movement of a tube (20) to surround the gripper fingers (31), due to the biassing force of a compression spring (23). The rearward manipulation of a thumb actuator (40), against the biassing force of the compression spring moves the tube rearwards in order to separate the gripper tips before and after the gripping operation.

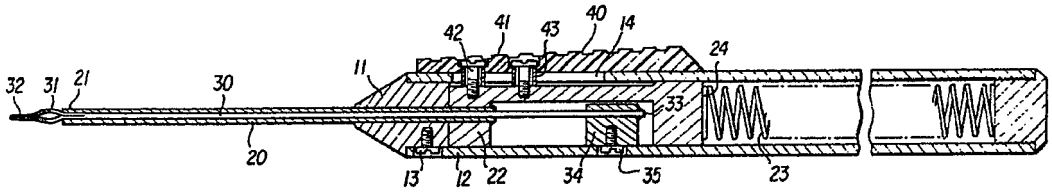

FIG. 2

GB 2 091 624 A

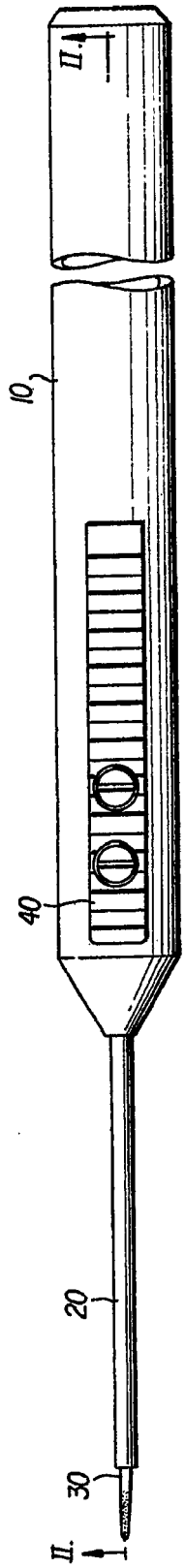
II
10
40
20
30
II

FIG. 1

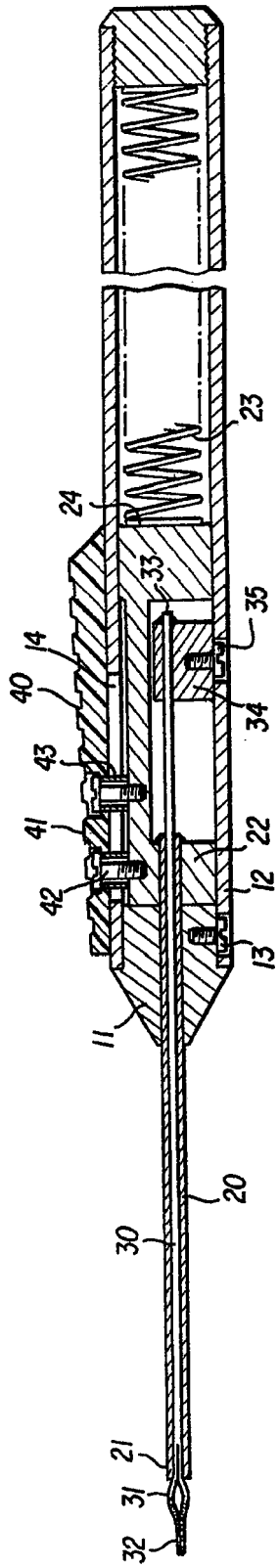
23
24
33
35
14
40
34
43
41
22
42
12
13
11
20
30
21
31
32

FIG. 2

SPECIFICATION

Foreign body forceps

The present invention relates to a forceps for removing foreign bodies from a human or animal body or body part. The forceps are particularly useful for removing foreign bodies from a human eye but are also useful for removing foreign bodies from other human or animal body parts.

It is often necessary for physicians or surgeons to remove a foreign body such as, for example, a piece of glass from a portion of a human or animal body. A problem which often occurs is the removal of a glass particle or other foreign body or particle from the human eye. In such removal, it is critical to ultilise an instrument which is able to grasp the foreign body in even extreme vicinities of the retinal surface.

Further, it is important that the retrieval instrument be able to grasp foreign bodies of various sizes and shapes. However, foreign body forceps which have been developed to date have all been limited to certain shapes of foreign bodies. Therefore a variety of forceps have been needed.

It is also important that a grasping mechanism be easily activated without awkward movement and with a minimal movement of the hand of the surgeon or physician, since awkward hand movements can cause undesired shifts in the position of the grasping mechanism. Clearly, when working in delicate environments such as the area surrounding the retinal surface, such undesired movements are to be avoided.

One known apparatus comprises an elastic ring applicator including a forceps whose jaws are retractable relative to a tube for the closing the forceps. The position of the tube with respect to the forceps is controlled by a pair of rings while a ratchet means is used for locking the gripping surfaces. These latching rings must be activated by the third and fourth fingers of the user's hand while the remaining finger or fingers steady the apparatus. However, it is difficult for an individual to move the third and fourth fingers of a hand without some movement of the other fingers and therefore any locking movement may result in some undesired movement of the forceps itself. Further, these fingers are relatively weak and the force required for gripping an object by movement of these fingers enhances the possibility of inadvertent hand movement.

Yet another important requirement for a forceps type grasping mechanism is the ability to grasp the foreign body with great holding strength and to securely grip the foreign body. Clearly, when working in a delicate environment such as the retinal surface it can be dangerous if the grasping mechanism were to release the foreign body back onto the retinal surface before the foreign body could be removed from the retinal area. In the known apparatus described above the ends of the gripping fingers are curved towards one another so as to increase the gripping force at the tips. However, even using stainless steel gripping tips the foreign bodies are often so hard that the tips are unable to securely engage the foreign body and the possibility exists that the foreign body may slip from between the tips of the grasping fingers.

It is an object of the present invention to provide a forceps for retrieving foreign bodies from a part of a human or animal body, particularly a human eye.

It is a further object of the present invention to provide a forceps whose gripping surfaces can engage or release a foreign body with minimal movements of the users hand.

It is another object of the present invention to provide a forceps whose gripping surfaces are able to securely grasp and penetrate the surface of even the hardest foreign bodies.

According to one aspect of the present invention, a forceps comprises a housing, a hollow tube having an open axial end, a rod fixed relative to the housing and axially moveable within the tube, the distal end of the rod terminating in at least two resiliently flexible jaws, the resiliency of the jaws being such as to tend to open their distal ends when the jaws extend beyond the distal end of the tube, means for moving the tube relative to the housing comprising a thumb actuated slider. The slider being connected to the tube, and biasing means tending to move the tube relative to the housing in a first direction.

The fingers are preferably made of a strong resilient material such as stainless steel, but can be made of other materials having similar resilient and non-corrosive properties. The surrounding tube which may also be formed of stainless steel. As the distal end of the tube approaches the tips, or gripping surfaces, of the fingers, the fingers are forced together by the tube and the gripping tips resiliently compress against a foreign body positioned therebetween.

According to another aspect of the present invention, the gripper fingers are plated with diamond dust. The hard diamond dust should be able to penetrate the surface of the foreign body, such as a glass sliver, and thereby securely grip the foreign body. The diamond particles on the gripping surface therefore make it almost impossible for the foreign body to slip from the gripping surfaces before they have been removed from the vicinity of the body part, such as the retina.

Since precision of movement and the avoidance of excessive or awkward movements of the forceps is important when retrieving foreign bodies from a body part, the present invention utilises a gripping surface engagement or locking system which is finger operated and which requires a minimal amount of movement of the gripping surface. With a forceps according to the present invention, the gripper fingers themselves can remain stationary with respect to the forceps while the tube is biased to move relative to the gripper fingers for forcing the gripping tips together. The tube is preferably held by a slider positioned within the forceps body and biased

towards a position which closes the gripper tips. The finger or thumb actuator located outside the forceps body is preferably connected to the slider and can be moved by the finger of a user in opposition to the biasing force of the spring so as to release the grip of the finger tips. If the finger actuator is released, the biasing means, such as a compression spring, will move the tube back into a position which closes the gripper tips.

In the use of the apparatus of the present invention, a user may retract the tube from the gripper tips by use of the actuator, thereby permitting the resilience of the fingers themselves to open the gripper tips. The gripper tips can then be placed adjacent the foreign body and the actuator gradually released. As a result of the release of the actuator, the gripper tips of the fingers remain stationary while the surrounding tube slides forward to cause the tips to clamp the foreign body. It is not necessary for the user to use force, which might cause an inadvertent movement of the gripper tips, in order to provide a secure clamping of the foreign body by the gripper tips, rather, the user simply releases the force already applied to retract the tube. The gripping force is provided by the compression spring which biases the gripper tips into a closed position. By the selection of a biasing spring of a desired spring force, sufficient force can be imparted to the clamping of the fingers so that the diamond dust is able to penetrate the surface of the foreign body to be retrieved. Further, since it is only one finger which is moved during the gripping operation, and since such movement is easily performed without movement of the remaining portions of the hand, the forceps of the present invention can be easily operated without the danger of inadvertent or undesired hand movements.

The invention may be carried into practice in various ways and one embodiment will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a plan view of the forceps of the present invention; and

Figure 2 is a partial section of the forceps on the plane II—II in Figure 1.

The major components of the forceps of the present invention, as seen in Figure 1, are a tubular handle or body 10, a tube 20, a rod 30 extending within the tube 20 and ending in a pair of fingers having gripping tips and an actuator 40 located on the body and attached to the tube 20. Although the actuator 40 can be manipulated by any finger, it will typically be actuated by the user's thumb, and will hereinafter be referred to as a thumb actuator.

Referring to Figure 2, the body 10 is preferably a cylindrical tube composed of stainless steel or a similar material which can be sterilised and which is not easily corroded. Preferably, the body has a knurled outer surface, is between 5 and 6 inches (12.7 and 15.2 cm) in length, and has a 0.375 inch (1.0 cm) diameter. A tapered stainless steel plug 11 is insertable into the front end 12 of the body and may be secured there by any suitable means such as screw 13. The plug 11 has a bore therethrough which is coaxial with the cylindrical body and within which the tube 20 can slide.

A longitudinal slot 14 is located on the body, at a point adjacent the front end thereof, and extending parallel to the axis of the body, and providing access to the interior of the hollow cylindrical body.

The rod 30 is also formed of stainless steel or other strong, resilient material which is easily sterilised. It is preferably about 0.035 inches (0.9 mm) in diameter and terminates at its distal end in a pair of fingers 31. The natural tendency of the fingers 31 is to separate from one another due to the resiliency of the material thereof so that, when not influenced by the tube 20, the tips 32 of the fingers 31 are spaced from one another.

The tips 32 are plated with a layer of very fine diamond dust (325 mesh; average diameter, 45 microns). The plating or bonding of diamond dust on a metallic substrate is well known, and the bond material may be a metal bond, a vitreous bond or a synthetic resin bond (for example, see A. Davidson, "Handbook of Precision Engineering", Volume 3, McGraw-Hill, 1966, pages 224—254). The rod 30 extends through the tube 20 and into the interior of the housing 10, wherein the other end 33 of the rod is fixed, as by welding, to a block 34 which is secured to the body by a screw 35.

The tube 20, which is also preferably formed of stainless steel, has a length of approximately 2 inches (5 cm) an outer diameter of approximately 0.048 inches (1.2 mm) and an inner diameter slightly larger than the rod 30 so that the rod 30 may slide therein without binding.

The distal end 21 of the tube is positionable adjacent the fingers 31 while the body of the tube 20 passes through, and is slidable within, the plug 11 of the body 10. The other end of the tube 20 is secured, as by welding, to a slider 22 which is slidable within the body 10 and whose forward movement is limited by contact with the plug 11. The slider 22 is biased forward into contact with the plug 11 by a compression spring 23 which extends between the rear end 24 of the slider and the rear end of the handle or body 10. When biased in its forward position by the compression spring 23, the distal end 21 of the tube extends to a point immediately behind the fingers 31. At this point, the edges of the distal end of the tube 20 overcome the resilient separating force of the fingers and force the tips 32 thereof together with considerable force (the ultimate degree of gripping pressure which can be applied by the tips 32 is dependent upon the strength of spring 23). Conversely, as the slider 22 and the tube 20 are moved rearwardly, against the biasing force of the spring 23, the resiliency of the fingers 31 permit them to separate, thereby separating the tips 32 so that the tips can surround a foreign body for gripping.

The stainless steel thumb actuator 40 has a serrated gripping surface 41 and extends

longitudinally over the slot 14 and the body 10. The thumb actuator is secured to the slider 22 so that movement of the slider (and the tube 20) can be effected by longitudinal sliding motion of the thumb actuator. The thumb actuator is positioned adjacent the front of the body where it is convenient for engagement by the thumb of a user.

The preferred means for securement of the thumb actuator to the slider 22 is by a pair of screws 42 extending through bores in the thumb actuator and threaded into the slider 22, the bores including shoulders for contact with the heads of the screws. Each of the screws includes a stainless steel spacer 43 having a diameter slightly smaller than the width of the slot for preventing circumferential movement of the thumb actuator. Further, the length of the spacers are such that the slider 22 and the thumb actuator 40 are maintained at a sufficient separation whereby easy sliding occurs without binding on the body 10.

The operation of the forceps of the present invention will now be described: the forceps is first gripped by a user in a manner such that thumb actuator is easily gripped and manipulated by the user's thumb. The thumb actuator is then slid rearwardly, thereby moving the slider 22 rearwardly against the biasing force of the spring 23. As a result, the distal end 21 of the tube 20 withdraws from the fingers 31 and permits them to separate due to their resiliency, thereby separating the gripper tips 32. The gripper tips may then be positioned around a foreign body on the retina, or within another body part. When the gripper tips 32 are properly positioned, the user gently releases the rearward pressure on the thumb actuator 41 so that the compression spring 23 will move the distal end 21 of the tube toward the gripper tips 32, thereby applying a strong closing force on the gripper tips. As the gripper tips close about the foreign body, the tube 21 continues to move forward until an equilibrium is reached between the spring force and the reaction force of the foreign body on the gripper tips. Due to the very hard diamond dust plated or bonded on the gripper tips, the diamond dust can actually penetrate the surface of the foreign body, thereby insuring a secure grip and minimising the possibility of inadvertent or premature release of the foreign body.

It is important to note that the manipulation of the thumb actuator is very convenient for the user since movement of the thumb can be easily accomplished without movement of the remainder of the fingers. Further, any contraction movements of the thumb which could cause an inadvertent movement involve the retraction of the thumb actuator and can be performed before the forceps is moved to the retinal area. Therefore, the only movements which are necessary during the delicate step of gripping the foreign body involve the release of the pressure already existing on the thumb actuator. Such a pressure release can be performed more smoothly and with less of a possibility of inadvertent hand movements than are possible where pressure is applied during the gripping step.

Although this embodiment has been described as having two gripper fingers 31, it will be appreciated that three or more fingers may be used.

CLAIMS

1. A forceps comprising a hollow housing, at least two jaws extending from one end of the housing, means for closing the jaws, and a gripping surface at the distal end of each of the jaws, the gripping surface comprising diamond particles bonded to the jaws.

2. A forceps comprising a housing, a hollow tube having an open axial end, a rod fixed relative to the housing and axially moveable within the tube, the distal end of the rod terminating in at least two resiliently flexible jaws, the resiliency of the jaws being such as to tend to open their distal ends, when the jaws extend beyond the distal end of the tube, means for moving the tube relative to the housing comprising a thumb actuated slider, the slider being connected to the tube, and biasing means tending to move the tube relative to the housing in a first direction.

3. A forceps as claimed in Claim 2 in which the first direction is towards the jaws.

4. A forceps as claimed in Claim 2 or Claim 3 in which the biasing means is a compression spring acting between the tube and the housing.

5. A forceps constructed and arranged substantially as herein specifically described with reference to and as shown in the accompanying drawings.

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